

Simulation and Comparison of Martian Surface Ionization Radiation

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The spectrum of energetic particle radiation and corresponding doses at the surface of Mars is being characterized by the Radiation Assessment Detector (RAD), one of ten science instruments on the Mars Science Laboratory (MSL) Curiosity Rover. The time series of dose rate for the first 300 Sols after landing on Mars on August 6, 2012 is presented here. For the comparison to RAD measurements of dose rate, Martian surface ionization radiation is simulated by utilizing observed space quantities. The GCR primary radiation spectrum is calculated by using the Badhwar–O’Neill 2011 (BO11) galactic cosmic ray (GCR) model, which has been developed by utilizing all balloon and satellite GCR measurements since 1955 and the newer 1997–2012 Advanced Composition Explorer (ACE) measurements. In the BO11 model, solar modulation of the GCR primary radiation spectrum is described in terms of the international smoothed sunspot number and a time delay function. For the transport of the impinging GCR primary radiation through Mars atmosphere, a vertical distribution of atmospheric thickness at each elevation is calculated using the vertical profiles of atmospheric temperature and pressure made by Mars Global Surveyor measurements. At Gale Crater in the southern hemisphere, the seasonal variation of atmospheric thickness is accounted for the daily atmospheric pressure measurements of the MSL Rover Environmental Monitoring Station (REMS) by using low- and high-density models for cool- and warm-season, respectively. The spherically distributed atmospheric distance is traced along the slant path, and the resultant directional shielding by Martian atmosphere is coupled with Curiosity vehicle for dose estimates. We present predictions of dose rate and comparison to the RAD measurements. The simulation agrees to within $\pm 20\%$ with the RAD measurements showing clearly the variation of dose rate by heliospheric conditions, and presenting the sensitivity of dose rate by atmospheric pressure, which has been found from the RAD experiments and driven by thermal tides on Martian surface.